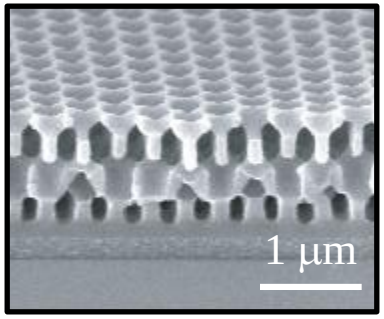
Ultralight Nanolattices with Co-Optimized Mechanical, Thermal, and Optical Properties

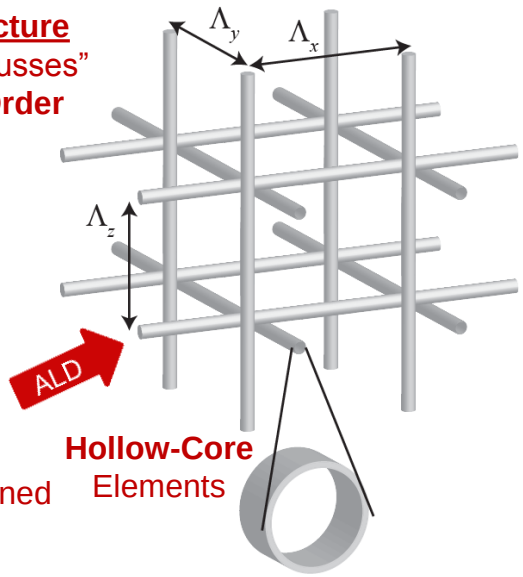
PI: Chih-Hao Chang

Department of Mechanical & Aerospace Engineering, North Carolina State University

Proposed Structure
Tubular "Nano-Trusses" with **Periodic Order**



3D Polymer Template Patterned using Nanolithography



Hollow-Core Elements

Scientific/Technical Impact:

- Develop nanolithography and atomic layer deposition (ALD) process to control ordered, 3D lattice parameters with **nm-level precision**
- Design nanomaterials like macroscale bridges and **lattice towers**
- Enables **ultralight** materials with:
  - ✓ Enhanced mechanical strength
  - ✓ Ultralow thermal conductivity
  - ✓ Broadband optical clarity

Objectives/Key Innovation:

- Design hollow-core tubular nanolattice to directly tailor **properties in multiple physical domains**:
  - ✓ **Mechanical**: Ordered lattice/hollow core enable optimal stiffness scaling at ultralow density.
  - ✓ **Thermal**: Nanoscale thin shells suppresses thermal conductivity by increasing surface phonon scattering
  - ✓ **Optical**: Subwavelength lattice period reduces optical scattering for broadband clarity

Potential Application(s):

- Replace **silica aerogel** with stronger, optically clear, thermal insulating materials
- Enables transparent, energy-dissipation material for **impact-absorbing windows**
- Enable **radiation-shielding** coating with extremely high surface area/volume ratio